Paper presented by F.E. Jarrige on behalf of the author in the International seminar on the 'First Farmers in Global Perspective', Lucknow, India, 18-20 January, 2006

The First Farmers in Western Pakistan : The Evidence of the Neolithic Agro-pastoral Settlement of Mehrgarh

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Introduction

The transition from mobile hunting and gathering to neolithic agricultural societies living in permanent villages took place about the time of the change from Pleistocene to Holocene. During this transition major climatic and environmental changes happened and temperature began to rise worldwide. It is generally accepted, mainly for the Southwest Asia, that the two events were related and the progressive change of the environment determined conditions in well definite piedmont zone or alluvial lowlands. In the early Holocene human communities of several parts of the Southwest Asia become more confident in the exploitation of those plants (wild cereals and legumes), which were the basic fodder for the animals that were their main source of food.

The traditional version for the beginning of the agricultural economy, for many nuclear areas of the world, is based on the domestication of plants and animals. In general, the adoption of farming was accompanied by the emergence of more complex organization, new forms of settlements and crafts. During the Neolithic Period sedentary societies were formed and their members lived in permanent villages and depended upon agriculture and pastoralism for their livelihood. The initial development of an agricultural way of life was probably a consequence or the result (adaptation) of a significant change in the environment.

The Kachi Plain was one region in the Northwestern South Asia where those changes in economy and social organization began, and Mehrgarh is the principal, but at present, the only settlement with the earliest evidence of agriculture.

The Neolithic Area of MR.3

The site of Mehrgarh is located south of the Bolan Pass, in the region of Baluchistan, to the west of the Indus River valley. It is generally considered the earliest neolithic settlements in that region, excavated by the French Archaeological Mission over eleven seasons of a large-scale and multi-disciplinary project.[1] The complexity of the archaeological area has demanded many efforts to the French mission to explain the stratigraphy of the site and the sequence of a great number of human occupations on a huge area of about 200 hectares, from the 8th millennium BC onward. The Neolithic deposit of Mehrgarh, aceramic and ceramic, was found in the MR.3 area, at the northern corner of the site, where

Received: 14 November 2006; Revised: 24 January 2007

a natural water-drainage channel reach the Bolan river.

The excavations in the neolithic deposit revealed the presence of two different events of human occupation: the first, Period I, represented by superimposed levels of aceramic Neolithic with typical stone industry; the second, Period IIA and B, characterized by chaff-tempered/coarse pottery, unbaked clay figurines and flint tools. Multi-rooms houses (compartmented buildings) made of mud bricks, excavated in the Neolithic MR.3, were considered as storage units. According to Jarrige[2] the Mehrgarh Neolithic sequence can be included in a span of time of about two thousand years, from the eighth to the end of the sixth millennium BC.

Archaeo-zoological investigations suggest that the earliest human communities exploited a faunal assemblage of at least 12 species (elephant, gazelle, swamp deer, nilgai, blackbuck, onager, chital, water buffalo, wild pig), with evidence of proto-domestication and domestication of local wild goat, sheep, and cattle.[3]

The Neolithic deposit in MR.3 gave a great amount of plant remains, in the form of charred seeds and impressions in mud bricks that represent the bulk of the most ancient agro-biodiversity of the Kachi Plain, on which the agricultural economy was based.[4] Evidences of the early-middle Holocene (between 8000 and 5000 years BP) vegetation were obtained from three archaeological sediment columns, for a total of 29 examined samples.[5]

The Early Agricultural Economy

Excavations in the Neolithic MR3 area were assisted by an archaeobotanical investigation to ensure the recovery of the plant remains.[6] Charred seeds and other macro remains were collected from archaeological soil samples using a simple dry sieving method, mainly from those contexts where the presence of ash layers was evident, because the negative results obtained from the water sieving tests. The archaeobotanical record of charred plant remains for the aceramic Neolithic Period I (end of the 8th and beginning of the 7th millennium BC) includes few barley grains (*Hordeum* sp.), some fruit stones of *Ziziphus* sp., a limited number of naked barley internodes (*Hordeum vulgare nudum*/ *sphaerococcum*), and einkorn/emmer spikelet forks (*Triticum monococcum*/ *dicoccum*) from the deepest levels of the sounding carried out in the area of MR3T. Barley and einkorn/emmer remains were recovered in soil samples or into mud brick fragments from the first architectural levels 1 and 2, in which evidence of multi rooms houses were found.[7]

The charred plant remains for the ceramic neolithic sequence were recovered in the soil samples from three main areas assigned to Period II A and B: MR3 (various *buildings*), MR3S (excavations carried out in the years 1983-84), MR 3/4 (sectors excavated mainly during the season 1983, and subsequently assigned to MR3), and MR 4 AG area and square A (sectors excavated from 1980 to 1982 and then included in the MR3 location). Grains of naked barley (*Hordeum vulgare nudum* and *Hordeum sphaerococcum*) and emmer (*Triticum dicoccum*) were found in the samples from Period IIA (6th millennium BC) associated with seeds of *Acacia*, fruit stones of *Ziziphus* and *Phoenix dactylifera*, and few seeds of *Gossypium* sp. The evidence of the last species originated perplexities and comments because no other documentation was available for such plant in a so early period. Finally, the recovery of mineralized fibers in a copper bead, from a Neolithic burial,[8] confirmed what was formerly proposed as the most ancient finds of *Gossypium* related with human activity and agriculture.[9] The archaeobotanical documentation for Neolithic Period IIB was more limited, including only few charred grains of two-row barley, (*Hordeum distichum*), hulled six-row barley (*Hordeum vulgare*), naked six-row barley (*Hordeum vulgare nudum* and *Hordeum sphaerococcum*) and emmer (*Triticum dicoccum*). The presence of single fruit stone of jujube and one of date palm was also recorded.

Another valuable source of information, for the early agricultural economy at Mehrgarh, was represented by the plant impressions found on and into the mud bricks. Chaff of the main cereal crops was used in preparing the blending of the two components, clay and straw, for the preparation of the mud bricks. Archaeologists easily recognized the presence of chaff impressions in the mud bricks during the excavations and many of them were collected for plant imprints examination. Some 50 brick and daub fragments from the aceramic deposit in MR3T and MR3 square A1A (MR.3S) were investigated and a total of about six thousand plant impressions were classified.

The study of the plant impressions was undertaken following the same method used to investigate the inclusions in potsherds, using a low-power light stereomicroscope to distinguish the predominant forms of the plant impressions on the surface of the bricks as well as in the inner structure, by means fresh break surfaces. Imprints of empty isolated glumes, spikelets and rachis internodes were the most frequent impression along with some almost complete ears were also found. Many imprints were very well preserved and some of them still contained grains or rachis internodes. The absence of stalk and leaf impressions was noticed as an event of remarkable importance, and as a clear indication that the raw material used in the manufacturing process of the mud bricks was the by-product of crops threshing and cleaning activity.

The bulk of the impressions from MR3T were identified as naked six-row barley (*Hordeum vulgare nudum* and *Hordeum sphaerococcum*), while less than the 10% of the total were imprints of two-row barley (*Hordeum spontaneum* and/or *distichum*), six-row barley (*Hordeum vulgare*), einkorn/emmer (*Triticum monococcum*/*dicoccum*), emmer (*Triticum dicoccum*), and free-threshing wheat (*Triticum durum/ aestivum*). A quite similar result was obtained from the analysis of the material of MR3 A1A location. None of the two-row barley imprints was definitely identified as from wild barley and the lack of any other wild species does not help to understand the relevance of the local biodiversity in the adoption/ adaptation of agriculture by the Neolithic communities settled at Mehrgarh.

According to the archaeobotanical documentation the agricultural economy at Mehrgarh was mainly based on the cultivation of the naked six-row barley, since the early beginning of the aceramic Neolithic period. The contemporary presence of others species of barley (six-row barley and two-row barley), glume wheats (einkorn and emmer) and free-threshing wheat can be interpreted as an archaic phase of an agricultural economy in which the selection of the single/specialized crop was not yet reached. Unfortunately, it has been possible to investigate only a limited part of the neolithic deposit and we can not yet state what the presence of wild plants was during the early beginning of human occupation of the site.

More considerations could be proposed comparing the evidence of Mehrgarh with those of some other Neolithic site but Mehrgarh is the unique settlement, in the whole Indus region, in which a Neolithic sequence was documented and investigated. Nevertheless, early agro-pastoralism of Mehrgarh should not be perceived as an isolated phenomenon, being documented events of early agriculture in territories bordering the northeastern Iranian Plateau. This is the case of Jeitun where archaeobotanical investigations documented the exploitation of einkorn, and six-row barley (both naked-grain and hulled-grain varieties) since the 6th millennium BC.[10] Several consideration were adopted by Harris[11] to reach the conclusion that crops and domestic animals were introduced to the Kopet Dag from west, existing strong similarities between the already developed Neolithic (c. 5000 BC) agropastoral system at Jeitun with the village-based grain-caprine economy of the PPNB in the Fertile Crescent. As conclusive remarks Harris[12] pointed out that "The evidence presently available decisively supports the hypothesis that it (*agropastoralism*) spread mainly by colonization during the 6th millennium BC across northern Iran within the belt of mediterranean climate that extends eastward past the Caspian Sea."

Harris' considerations on Neolithic Jeitun can not be so useful in searching the origin of aceramic Neolithic agro-pastoral system at Mehrgarh because chronological diversity, but the question from where it arose "...from where agriculture and pastoralism later spread to secondary or non center" is similar. If we consider the earliest plant evidences from Mehrgarh we may assume that only a set of information (imprints of *Hordeum spontaneum*), still uncertain, can be interpreted as indicator of a possible exploitation of a wild local resources, while all the others indicate that agriculture was founded on domesticated species. This could means that the first agriculturists reached the plain south of the Bolan river when the evolution of their main crops (mainly barley) already had happened, or that the evidence of a previous step in the selection of food plants from wild stands is still buried in the plain or in some other place in the region.

The Environment of the Kachi Plain in the Early-middle Holocene

The Kachi Plain is a flat alluvial area which is part of a more extensive territory situated between the eastern edge of the Iranian Plateau and the Indus Valley, while to the south the great desert of Baluchistan separates it from the Makran region. To the north the mountains of Quetta represent a natural boundary with crossed by the Bolan River, a natural communication route since the earliest time. The geographical pattern of the Kachi Plain could have been the most important condition to establish a local/regional event of neolithization of the territory, well connected with various ecosystems in which the natural resources could be exploited over the different seasons. Thus, Mehrgarh formed a geographical and cultural unit throughout the Neolithic and indeed for some time before, making it a region of particular interest in which to study the emergence of the new way of life. The discovery of Mehrgarh Neolithic area changed the consideration of the Indus valley as marginal territory in the early development of agriculture, opening a large debate on the possibility that the Kachi plain could have been an early agricultural centre.

The transition to farming can be considered as a mere economical process but being involved "local/ regional" biological resources (from wild to domesticated, plants and animals) it should be appropriate to take into consideration what was the prevailing environment in the area of interest and how did it condition changing human resource use. Plant and animal biodiversity played an important role in the dynamic interaction between human communities and the territory, being they at the base of the carrying capacity of the area.

Climate and vegetation were different at the beginning of the Holocene and, generally speaking, they varied considerably from region to region.[13] During the beginning-mid Holocene, climate played a fundamental role in the modification of the land surface, determining favorable conditions for human occupation in those regions where vegetation, lakes and wetlands were positive modified by the increasing of temperature and humidity. According to Gupta *et al.*,[14] human occupation and migrations have been closely related to climate changes and, in particular, the evolution of human civilization rapidly evolved along perennial river systems. The Bolan River and the Kachi Plain, as part of the more extensive system of the Indus River, represented a suitable region of rapid adaptation for the first human communities during the early Neolithic.

For several time that part of the Indian subcontinent was believed too hot and dried to host the early agriculture, until the Harappan civilization. This idea was mainly due to limited information on Holocene climate fluctuations and their importance for the human population in the region. The knowledge on climate and vegetation of that part of Baluchistan was founded mainly on archaeological consideration. Various authors adopted two different opinions: the first was oriented on more humid conditions;[15] the second proposed that the climate in Sind and Baluchistan was characterized by aridity as at present time.[16] The last opinion was supported by a palynological investigation carried out at Balakot, in Las Bela region, but only for the Harappan period.[17]

Starting from 1988, a five-years palynological project at Mehrgarh began with the main purpose to investigate the deepest level of the neolithic sequence, to study the evolution of the vegetation in central Baluchistan during the Holocene period.[18] Three continuous series of soil samples were collected from the natural cliff along the Bolan River, in a section where the beginning of the Neolithic sequence was just above the natural soil. Columns 1 and 2 were arranged in a stratigraphical sequence, with a zone of overlapping, while column 3 both summarizes and extents them. Chemical features and the result of the soil texture analysis demonstrate that in the three columns there were equal depositional events with a precise correlation between the samples of columns 2 and 3, while column 1 was mostly included in a compacted pre-occupational (natural) deposit.

Conventional radiocarbon dates were obtained from two samples of column 3: sample n. 4, collected near the top of the column, gave a result of 6146 ± 60 yrs BP (R-2289), sample n. 11, from bottom of the series, was dated to 7928 ±126 yrs BP (R-2290). A third sample submitted for radiocarbon dating (n. 4 of column 2 from the same archaeological layer of sample n. 4 of column 3) produced a radiocarbon date of 6085 ± 69 yrs BP (R-2288). The bulk of the investigated Neolithic deposit is closed in a space of time of about two thousand years, between the beginnings of the VIth millennium BC and the end of the Vth millennium BC, considering uncalibrates values, or between the first half of the VIIth millennium BC and the end of the VIth millennium BC, using calibrated values.

The pollen analysis carried out on the soil samples of the three columns provided a unique picture of the past vegetation, being them perfectly comparable and the total amount of the pollen grains quite significant, despite the nature of the deposit. The pollen of arboreal plants (AP) is present in relevant percentages with a range of variation between 62 and 70 %, with a minimum of about 51% in the deepest sample. Non-arboreal plants (NAP) include all herbaceous pollen types, summing together also the cerealia-type pollen grains.[19]

A limited number of taxa, between 20 and 30, were represented in the three pollen diagrams with a low percentage of long-distance transport elements like, *Abies*, *Picea*, *Tsuga*, *Pinus*, *Juniperus*, *Quercus*, *Tilia* and *Corylus*. An important group of arboreal plants was represented by *Populus*, *Salix*, *Fraxinus* and *Ulmus*, whose pollen sum reaches about the 50% of the total of the pollen grains. The presence of *Vitis* is well documented in the pollen diagrams with a constant value between 4 and 7%. The taxa of NAP included Cyperaceae, *Phragmites*, *Typha*, *Alisma*, *Myriophyllum*, and *Nymphea*, typical species of humid and aquatic environments, and gramineae, leguminosae and cerealia-type classified as plants of dry or not wet environments.

The species identified from the aceramic Neolithic Period I, grouped in conventional classes according to Zohary,[20] reflect the great physiographic, climatic and edaphic contrasts in the territory, not excluding a relevant contribution, in terms of pollen grains, from mountainous environments of the Himalayan belt.

Mountain vegetation includes all the coniferous trees as components of various plant communities, limited to the high mountains. Juniper has been listed in this class as the present-day juniper forest still grows at an altitude ranging from 1800 mt. to 3000 mt. The juniper forest is actually confined to a very limited area in the Ziarat valley (north of Kachi plain) where the existing trees are thousands years old. The trees are growing in poor soil under extremely harsh conditions, with an average annual rainfall of 200, 250 mm. The juniper forest at Ziarat is a relict of past vegetations, which probably covered a more extensive area.

A second group of arboreal vegetation is represented by the oak forest or oak stands with a few species of deciduous trees included in this group. It is possible to assume that this class of vegetation might grow in the interior plains and hills as well as in the mountainous slopes.

Four of the eight proposed classes are of hydrophitic vegetation with a present-day diffusion in warm-temperate and sub-tropical regions. These four classes are documented by the pollen of leading plants of this type of vegetation, which inhabits banks of permanent or ephemerous water courses, inland lakes and swamps.

The riverine vegetation is documented by its most important elements, like *Populus*, *Salix*, *Fraxinus* and *Ulmus* often arranged in dense concentric or parallel belts forming thick forest stands or gallery forest along the rivers. The presence of *Vitis* has been recorded since the deepest level of the Neolithic pollen sequence, can be considered a floristic element associated with the riverine forest, as in many natural environment of the Near and Middle East. The presence of ponds and marshy areas was also documented by the pollen grains of waterlogged and aquatic plants. In such of environmental complexity, evidence of cerealia-type pollen grains were found from the early beginning of the aceramic settlement but also in the soil samples immediately below of the first level of human occupation.

Similar results were obtained from pollen analysis carried out on mud bricks fragments from MR3T and MR3S square A1A, on which a lot of barley and wheat impressions were present. According to Robinson and Hubbard,[21] the cereal spikes may represent potential traps for pollen grains and, when chaff and straw were blended with clay to produce the Neolithic mud bricks, pollen grains of cereals and other plant species were incorporated. The pollen grains were well preserved like those found in the soil samples, being the examined Neolithic mud bricks unbaked.

The presence of *Tamarix* and Palmae, among the arboreal plants, and *Smilax*, *Fumaria* and Chenopodiaceae, in the group of non arboreal plants, within a general of picture of humid environment, was documented by the pollen grains found in a fourth column sampled in the Neolithic sequence of MR3, between the end of Period I and the beginning of Period IIA.

Conclusions

By synthesizing archaeological, archaeobotanical and palynological data for the early-middle Holocene at Mehrgarh, and considering the effects of general climatic changes on local scale, it is possible to draw up a possible perspective on the Neolithic adaptation at the environmental conditions of the Kachi Plain. The interdisciplinary approach has provided a climatic and ecological picture for the timing of the spread of farming across the Indus Valley, south of the Chiltan and Koh-i-Murdar mountains.

The archaeobotanical data from the early Neolithic contexts provides substantial evidence for a Neolithic farming economy in the Kachi Plain between the end of the 8th and beginning of the 7th millennium BC. This does not preclude earliest attempts at agriculture in this transitional region where the Bolan river might have represented an important lane of connection, but also the major element of the plain landscape modification caused by its flooding events.

The main crops of the inhabitants of the Neolithic settlement of Mehrgarh were naked six-row barley (*Hordeum vulgare nudum* and *Hordeum sphaerococcum*), six-row barley (*Hordeum vulgare*, emmer (*Triticum dicoccum*), and a free-threshing wheat species (*Triticum durum/aestivum*), all cultivated species of wheat and barley of south-west Asia origins, while the presence of wild barley, although still uncertain, is the only element that led us to think to an exploitation of local resources. On the contrary, the study of animal bones strongly support the hypothesis of local domestication of sheep and cattle.[22]

The results of the pollen analysis show that, from about 8000 yrs BP to about 6000 yrs BP, the region was dominated by a semi-lacustrine or humid environment with a riverine vegetation, with *Populus*, *Salix*, *Tamarix*, *Fraxinus*, *Ulmus* and *Vitis*, associated in a typical hydrophitic complex, along the Bolan River or the streams crossing the plain. Remnants of a similar riverine forest were still present along the lower course of the Hilmand river, in Iranian Sistan-Baluchistan, during the third-second millennium BC, as proved by the great number of wood remains and charcoals of poplar, tamarisk, ash, elm and grapevine found at the Bronze age site of Shahr-i Sokhta.[23] Part of the Kachi plain was covered by annual herbaceous vegetation (mainly Gramineae and Leguminosae) forming large open zones, while stands of oak forest probably grew in the upper levels.

As final result of the interpretation of the pollen sequence from the Neolithic deposit of Mehrgarh it is possible to point out that three major wet events were registered from the first half of the VIIth millennium BC and the end of the VIth millennium BC, with a tendency to less humid conditions.

The proposed climatic conditions of the Kachi Plain during the early-middle Holocene reflect a more general trend of an increasing of humidity widespread not only in southwest Asia but founded on integrated studies of pollen and lake-level records, suggest wetter conditions that at present in the Indo-Arabian sector for both 9000 and 6000 yrs BP.[24] Also in east Africa a humid period had been established in the east Sahara during the early and middle Holocene.[25] More recent investigations approached the question of the Holocene climate variability and related evolution of natural vegetation in south Asia from different point of view. A great deal of scientific work has been done for the western Rajasthan[26] but also several general overviews included the Indus valley in the framework of Saharo-Arabian climate and vegetations dynamics.[27] According to Staubwasser *et al.*,[28] a most prominent event of the early-mid Holocene monsoon occurred after 8400 yrs BP and a solar-output model, for the period 14000-2000 yrs BP, shows that a global chill event can be dated near 8200 yrs BP,[29] while two others cold picks (Sahara Aridity) can be dated near 7000 yrs BP and at 5500 yrs BP. The cold events were short periods in a more general warm-up climate tendency initiated at the beginning of the Holocene period with a rapid warming dated at 7600 yrs BP.[30] More rain, longer growing seasons, more land to settle on and more crops characterized the warmer climate. As result of the solar heating in the boreal hemisphere, between 9000 and 6000 yrs BP (10500-6500 cal. yrs BP), the monsoon rains increased over North Africa, Arabian Peninsula and northwestern south Asia, causing a major lacustrine phase.[31] In the framework of the Holocene climate variability, a close relationship between monsoon precipitation and historical changes along the Indus valley has been proved mainly for the mid-late Holocene.[32]

The evidence of Mehrgarh is coherent with the general and regional proposed evolution of climate, and a deepest investigation in all the archaeological sequence of Mehrgarh could provide a detailed information on how climate and related landscape modification impacted on human settlement and use of riverine environments. More emphasis would have to be given to the study of the dynamic relation between human behavior and river environments in a place, the Indus valley, where the river(s) have played an important role as stimulus of cultural evolution.

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